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Research Article

Assessment and Identification of Major Weeds on Wheat (*Triticum aestivum)* in East Shewa and West Arsi, Zones, Oromia

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Abstract

Wheat, maize, and rice 80% of global cereal production. Weeds pose a significant challenge for cereal crop cultivation, and effective weed control is essential for boosting yields. To better understand weed populations within agricultural systems, surveys are commonly conducted. Consequently, a comprehensive weed survey is vital for addressing current weed issues affecting major cereal crops. The primary objective of this survey was to assess and identify the prevalent weeds associated with wheat in the key production areas of the Central Rift Valley in Oromia. The weed survey took place in the East Shewa and West Arsi zones of the Oromia Regional State during the main cropping seasons from 2021 to 2023. It was carried out in 34 kebeles across 97 fields within seven districts of the two zones. Key parameters analyzed for each crop included density, frequency, relative frequency, and similarity index. Overall, in most crops and districts, annual broadleaf weeds were more prevalent than grasses and sedges. The Asteraceae family emerged as the most dominant, hosting the highest number of weed species across all assessed crops and fields, followed by the Poaceae and Amaranthaceae families. Notably, the composition of weeds was generally consistent across various districts, as indicated by the similarity index. The frequency of individual weed species in wheat fields varied, ranging from 1% to 91%, while the dominance values ranged from 0.71% to 21.92%. The most frequently encountered and dominant weeds included Galinsoga parviflora and Argemone mexicana L. for wheat, with Galinsoga parviflora being followed by Nicandra physalodes, Conyza bonariensis, and Commelina benghalensis.

Keywords

Family, Distribution, Major Cereals, Frequency, Weed, *Galensoga Palviflora*

1. Introduction

1.1. Background and Justification

Wheat, maize, and rice 80% of cereal production globally. In Ethiopia, some of the primary cereals cultivated include tef [*Eragrostis tef*], maize [Zea mays L.], bread wheat [*Triticum aestivum L.*], durum wheat [*Triticum durum Desf.*], barley [Hordeum vulgare L.], sorghum [Sorghum bicolor L.], rice [*Oryza sativa L.*], and finger millet [*Eleusine coracana L.]* [1].

Although these cereals are vital for Ethiopian agriculture, the average national yield stands at 2600.75 kg/ha, which is 12% lower than the average yield across Africa and 24% below the global average for wheat [2]. Several factors contribute to

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reduced yields in cereal crops, including declining soil fertility, weeds, pests, and diseases. Among these, weeds pose a particularly significant challenge to cereal production, making weed control essential for increasing yields [3, 4]. Weeds are unwelcome plants that invade various crops and negatively impact yields by competing for resources like water, nutrients, space, and light [5]. Numerous studies highlight the detrimental effects of weeds on crop plants [6]. Moreover, weed infestation can exacerbate disease issues, provide a habitat for harmful insects, hinder harvesting, complicate farming operations, raise production costs, lower the market value of crops, and heighten the risk of fire in perennial crops, plantations, and forest reserves [7, 8]. Surprisingly, many farmers may not fully recognize the extent of the negative impact weeds have; studies suggest that weeds account for up to 45% of total annual agricultural losses [9].

Globally, over 10% of agricultural output is lost due to competition from weeds for essential resources like light, water, and nutrients [10]. Annually, weeds contribute to an overall loss of about 45% in agricultural production [11]. In Africa specifically, yield losses from weed competition can range from 55% to 90% for maize, 50% for tef, 50-55% for sorghum, 60-73% for barley, 50-100% for rice, 80% for cotton, 50-80% for wheat, and an astonishing 90% for cassava [12, 13]. On average, it is estimated that weeds cause around 10% yield losses in less developed countries and 25% in the least developed nations [12]. Currently, weeds significantly complicate pest management issues, making effective weed control one of the main challenges farmers faces in cultivating arable crops [14]. Weed surveys play a crucial role in understanding weed populations within cropping systems [15]. Research has shown that globally, more than 10% of agricultural output is lost due to competition between crops and weeds for essential resources such as light, water, and nutrients [10, 16]. As noted in [12], uncontrolled weeds can lead to yield losses that range from 20% to 100%, influenced by the specific crop and environment. The author reported estimated losses of 5% in developed nations, 10% in developing countries, and 25% in the least developed regions [16]. To devise an effective weed management strategy, conducting weed surveys is essential for addressing the existing weed challenges in key cereal crops. Furthermore, the information gathered from these surveys is vital for shaping targeted research and control measures. However, there has been a lack of in-depth studies concerning the occurrence and distribution of common weeds associated with wheat in the Central Rift Valley of Ethiopia.

1.2. Objective

To assess and identify the common weeds found in wheat production areas of the Central Rift Valley of Oromia.

2. Materials and Methods

2.1. Study Area Description

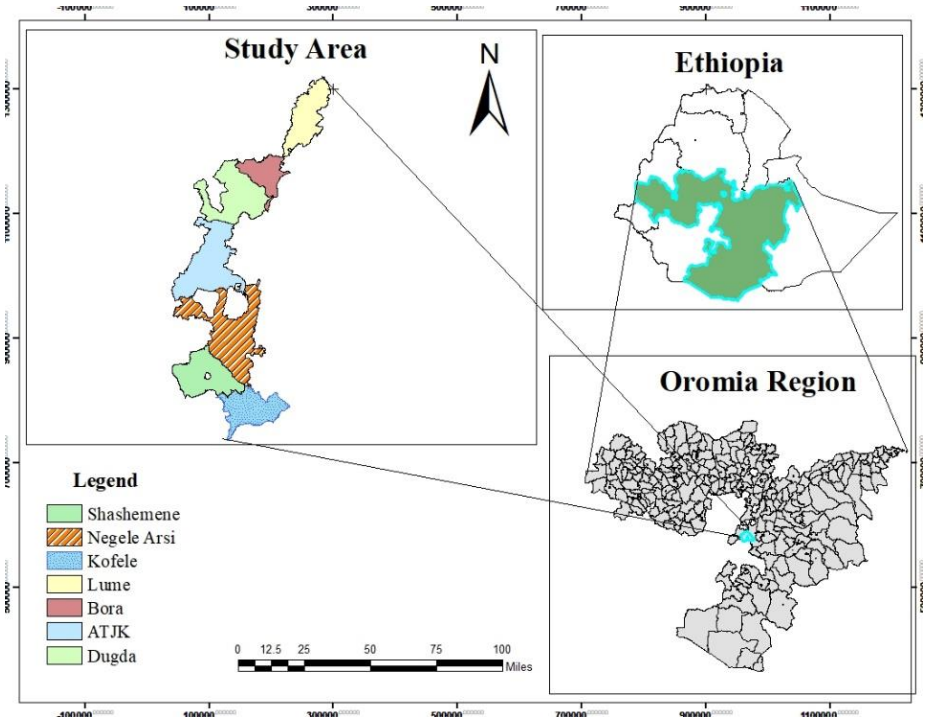

Figure 1. *Map of survey site.*

The weed survey was carried out in the East Shewa and West Arsi zones of the Oromia Regional State during the main cropping seasons from 2021 to 2023. The survey included seven districts: ATJK, Dugda, Bora, Lume, Negelle Arsi, Shashemanne, and Kofele. The assessment focused on measuring the density, frequency, relative density, relative frequency, and similarity index of various weeds. The geographical coordinates of the surveyed regions spanned from 8 ° 34' 59.99" N and 39 °09' 60.00" E to 7 °09' 60.00" N and 38 ° 49' 59.99" E, as depicted in Figure 1.

2.2. Field Survey

Table 1. *Characteristic Features of Surveyed Wheat fields in Two Zones of Study Area.*

ZONE	Study area.	Altitude (ab.ms.l)	no of field assesed
East Shewa	ATJK	1647-1843	12
	Dudga	1657-1761	18
	Bora	1595-1680	14
	Lume	1664-1907	14
West Arsi	Negelle Arsi	1720-1921	18
	Shashemanne	2133-2169	15
	Kofele	2398-2300	6
	Over all mean	1595-2300	97
	no of kebele		34

m.a.s.l. = Meter Above Sea Level

The survey was conducted at the wheat fields in 34 kebeles and 97 fields in the seven Districts of the two zones. Purposive sampling technique was applied to select Districts. Purposive sampling technique was applied to select Districts. Kebele were Randomly selected from each Districts based on the potential production of the wheat. Consecutive sample sites for the same crop were 5 km apart depending on the topography and the relative importance of the crop within each location. Weed assessment was made along the two diagonals (in an "X" pattern) of the field from three points using 0.5 m ×0.5 m (0.25 m^2) for wheat. Frequency (F), Density (D) and Similarity Index (SI) were computed for each species of weeds using the method of [17]. The collected weed data were combined and summarized. In each field, weeds specie and their numbers within the quadrates were counted and recorded.

Farmers were interviewed using pre-structured questionaries record information on farmers' practices such as: - the cereal crop and management practices, variety/ies grown whether local or improved, previous crop (cereals, pulses or vegetables), planting date (sowing time), crop density, altitude, fertilizer type and rate, soil type, growth stage, disease type observed and herbicides used were collected as to the survey format.

2.3. Data Analysis

Density, Relative Density, Frequency, Relative Frequency and Similarity index were calculated by the following formula. The collected weed data were combined and summarized using MS Excel and Minitab (17.0) version software.

$$\text{Density (D)} = \frac{\text{Total No of individuals of a species in all quadrant}}{\text{Total No of quadran used}}$$

$$\text{Frequency (F)} = \frac{\text{No of quadrantes in which a given speceis ocuurs}}{\text{Total No of quadrant used}}$$

$$\text{Relative density (RD)} = \frac{\text{Densityof a given species}}{\text{Rotal density for all spcies}} X100$$

$$\text{Relative frequency (RF)} = \frac{\text{Frequency of a given species}}{\text{Total frequency for all species}} X100$$

$$\text{Summed dominant ratio (SDR)} = \frac{\text{Relative density}}{\text{Relative frequency}} X100$$

$$\text{Similarity Index (SI)} = Epg/(Epg + Epa + Epb)\ X\ 100$$

Where; SI = Similarity index, Epg = number of species found in both locations, Epa = number of species found only in location I. Epb = number of species found only in locations II.

3. Result and Discussion

3.1. Diversity of Weeds in Wheat Fields

Sixty-two (62) weed species from thirty-three (33) families were identified in the wheat fields. The greater majority weeds (35) species were annuals, (24) species) were perennials and whereas [3] species were found to be Biennials. Twelves [12] 36.4% weed species belonged to the family *Asteracea*, ten [10] 30.3% species were *Poaceae* families, four [4] 12.12% species were *Solanaceae* families, three [3] 9.1 species were *Amaranthaceae* families and others rest families were less than two [2] species [Table. 3]. Hence these four families accounted for 87.88% of the total weed species recorded in the wheat fields for the last couple years study area. According [18] this could be perhaps due to their adaptability to a wide range of environmental conditions and soil types. These families, *Asteracea, Poaceae, Solanaceae and Amaranthaceae* have been reported to be important in the mid rift valley of Oromia.

Table 2. Number of weed families and number of species they comprise in the wheat fields.

No.	Family	No. of species	No.	Family	No. of species
1	Asteraceae	12	18	Commelinaceae	1
2	Poaceae	10	19	Compositae	1
3	Solanaceae	4	20	Eragrostidae	1
4	Amaranthaceae	3	21	Fabaceae	1
5	Cyperaceae	2	22	Lamiaceae	1
6	Euphorbiaceae	2	23	Leguminosae	1
7	Polygonaceae	2	24	Malvaceae	1
8	Ranunculaceae	2	25	Onagraceae	1
9	Convolvulaceae	1	26	Oxalidaceae	1
10	Lamiaceae	1	27	Panicae	1
11	Papaveraceae	1	28	Portulacaceae	1
12	Polygonaceae	1	29	Primulaceae	1
13	Apiaceae	1	30	Rubiaceae	1
14	Boraginaceae	1	31	Trichocomaceae	1
15	Brassicaceae	1	32	Typhaceae	1
16	Caryophyllaceae	1	33	Verbanaceae	1
17	Cleomaceae	1	-	-	-
	Total				62

3.2. Weed Flora of Wheat Fields

The result of assessments showed that, broad leaf weeds dominated over grass and sedge weed species [Table 3]. Forty-six (46) weed species [74.23%] were broad leaf, thirteen [13] weed species [20.96%] were grass type and the remaining three [3] weed species [4.83%] were found to be sedge types. The frequency of occurrence of individual weed species ranged from 1.0%-67.0% [Table 3]. Dominant weed species those species which occurred in relatively greater number than the other species. Eleven weed species *i.e Galensoga palviflora, Argemone mexicana L., Nicandra physlodes, Bidense Pilosa, Pennisetum setaceum, Amaranthus spinosus, Cyprus esculentus, Digitaria diagonalis, Eragrostis Cilianen, Setria verticelata* and *Avena fatua* were widely distributed with higher than 30% frequency while seventeen [17] weed species had ranged 10%-26% frequency value and remaining were thirty-four (34) weed species had lower than 10% frequency value. The species that had the highest frequency of 67.00% was *Galensoga palviflora* followed by frequency of 54% and 51% for *Argemone mexicana L., Nicandra physlode* respectively.

Table 3. Description of Density, Frequency, Relative Density, and Relative Frequency of weed in wheat fields.

Botaical Name	family	Category	Life Cycle	Density	Frequency	RD	FR	SD
Agerantum conyoides	Asteraceae	Broad Leaf	Annual	5.06	0.06	2.26	0.76	298.98
Amaranthus albus L.	Amaranthaceae	Broad Leaf	Annual	4.00	0.01	1.79	0.13	1419.34
Amaranthus hybrid	Amaranthaceae	Broad Leaf	Annual	3.97	0.04	1.78	0.50	352.37
Amaranthus spinosus	Amaranthaceae	Broad Leaf	Annual	3.73	0.38	1.67	4.54	36.72
Anagallis arvensis	Primulaceae	Broad Leaf	Annual	3.83	0.11	1.72	1.26	136.02

Botaical Name	family	Category	Life Cycle	Density	Frequency	RD	FR	SD
Argemone mexicana L.	Papaveraceae	Broad Leaf	Annual	4.56	0.54	2.04	6.44	31.73
Aspergillus niger	Trichocomaceae	Sedge	Annual	0.70	0.01	0.31	0.13	248.39
Avena fatua	Poaceae	Grassy	Annual	4.27	0.30	1.91	3.53	54.06
Bidense pilosa	Asteraceae	Broad Leaf	Annual	3.97	0.43	1.78	5.05	35.20
Brassica juncea	Brassicaceae	Broad Leaf	Annual	3.55	0.12	1.59	1.39	114.37
Bromus tectorum	Poaceae	Grassy	Annual	4.35	0.22	1.95	2.65	73.49
Chenopodium album	Asteraceae	Broad Leaf	Annual	2.73	0.22	1.22	2.65	46.13
Cleome viscosa	Cleomaceae	Broad Leaf	Annual	3.30	0.01	1.48	0.13	1170.96
Clotariaincana.L	Fabaceae	Broad Leaf	Annual	0.30	0.01	0.13	0.13	106.45
Commelina benghalensis	Commelinaceae	Broad Leaf	Annual	2.33	0.26	1.04	3.03	34.50
Convolvulus	Convolvulaceae	Broad Leaf	Pennerial	1.70	0.01	0.76	0.13	603.22
Cosmos sulphureus	Asteraceae	Broad Leaf	Annual	0.70	0.01	0.31	0.13	248.39
Cynodon dactlyon	Poaceae	Grassy	Pennerial	5.62	0.22	2.52	2.65	95.03
Cynoglossum creticum	Boraginaceae	Broad Leaf	Biennial	0.30	0.01	0.13	0.13	106.45
Cyprus esculentus	Cyperaceae	Sedge	Pennerial	7.66	0.38	3.43	4.54	75.51
Cyprus rotundus	Cyperaceae	Sedge	Pennerial	7.06	0.17	3.16	2.02	156.63
Datura stramonium	Solanaceae	Broad Leaf	Annual	1.97	0.13	0.88	1.51	58.32
Delphinium leroyi	Ranunculaceae	Broad Leaf	Pennerial	6.00	0.02	2.69	0.25	1064.51
Digitaria diagonalis	Poaceae	Grassy	Pennerial	3.66	0.37	1.64	4.42	37.14
Echinochloa esculenta	Poaceae	Grassy	Pennerial	2.63	0.09	1.18	1.01	116.43
Eleusine indica	Poaceae	Grassy	Pennerial	2.99	0.11	1.34	1.26	106.06
Eragrostis Cilianen	Eragrostidae	Grassy	Annual	4.20	0.33	1.88	3.91	48.08
Euphorbia esula	Euphorbiaceae	Broad Leaf	Pennerial	2.33	0.21	1.04	2.52	41.30
Euphorbia hirta	Euphorbiaceae	Broad Leaf	Pennerial	0.70	0.01	0.31	0.13	248.39
Foeniculum vulgare Mill	Apiaceae	Broad Leaf	Pennerial	5.00	0.01	2.24	0.13	1774.18
Galensoga palviflora	Asteraceae	Broad Leaf	Annual	6.99	0.67	3.13	7.95	39.35
Galium spurium	Rubiaceae	Broad Leaf	Annual	3.93	0.05	1.76	0.63	279.14
Gozotia abisinica	Asteraceae	Broad Leaf	Annual	3.28	0.24	1.47	2.90	50.61
Hieracium snowdoniense	Asteraceae	Broad Leaf	Annual	6.59	0.17	2.95	2.02	146.15
Leersia hexandra	Poaceae	Grassy	Pennerial	5.70	0.01	2.55	0.13	2022.57
Leucas aspera	Lamiaceae	Broad Leaf	Annual	3.18	0.10	1.42	1.14	125.34
Malva neglecta	Malvaceae	Broad Leaf	Annual	2.70	0.01	1.21	0.13	958.06
Nicandra physlodes	Solanaceae	Broad Leaf	Annual	3.03	0.51	1.36	6.06	22.38
Oenothera biennis	Onagraceae	Broad Leaf	Biennial	7.20	0.01	3.22	0.13	2554.82
Oxalis acetosella	Oxalidaceae	Broad Leaf	Pennerial	3.73	0.05	1.67	0.63	264.94
Oxygonum	Polygonaceae	Broad Leaf	Pennerial	0.70	0.01	0.31	0.13	248.39
Parthiunium Hystero-phoros	Asteraceae	Broad Leaf	Annual	2.87	0.14	1.29	1.64	78.39
Pennisetum setaceum	Poaceae	Grassy	Pennerial	5.77	0.40	2.58	4.80	53.90

Botaical Name	family	Category	Life Cycle	Density	Frequency	RD	FR	SD
Phyla nodiflora	Verbanaceae	Broad Leaf	Pennerial	0.70	0.01	0.31	0.13	248.39
Physalis angulata	Solanaceae	Broad Leaf	Annual	1.70	0.01	0.76	0.13	603.22
Polygonum arenastrum	Polygonaceae	Broad Leaf	Pennerial	3.19	0.07	1.43	0.88	161.73
Portulaca oleracea	Portulacaceae	Broad Leaf	Pennerial	3.25	0.04	1.46	0.50	288.30
Ranunculus asiaticus	Ranunculaceae	Broad Leaf	Pennerial	8.33	0.02	3.73	0.25	1478.48
Rumex crispus	Polygonaceae	Broad Leaf	Pennerial	0.30	0.01	0.13	0.13	106.45
salvia officinalis	Lamiaceae	Broad Leaf	Pennerial	4.08	0.04	1.83	0.50	362.23
Setaria pumila	Poaceae	Grassy	Annual	7.03	0.13	3.15	1.51	207.81
Setria verticelata	Panicae	Grassy	Annual	3.61	0.31	1.62	3.66	44.21
Silybum marianum	Asteraceae	Broad Leaf	Biennial	1.76	0.06	0.79	0.76	104.04
Solanum nigrum	Solanaceae	Broad Leaf	Annual	3.00	0.02	1.34	0.25	532.25
Sonchus oleraceus	Compositae	Broad Leaf	Annual	4.33	0.05	1.94	0.63	307.52
Spergula arvensis	Caryophyllaceae	Broad Leaf	Annual	0.70	0.01	0.31	0.13	248.39
Tagetes minuta	Asteraceae	Broad Leaf	Annual	9.72	0.02	4.35	0.25	1724.90
Themeda triandra	Poaceae	Grassy	Perennial	5.17	0.02	2.31	0.25	916.66
Typha angustifolia	Typhaceae	Grassy	Perennial	2.67	0.04	1.19	0.50	236.56
Vigna luteola (Jacq.) Benth.	Leguminosae	Broad Leaf	Perennial	0.30	0.01	0.13	0.13	106.45
Xanthium spinosum	Asteraceae	Broad Leaf	Annual	1.95	0.10	0.87	1.14	76.91
Xanthium strumarium	Asteraceae	Broad Leaf	Annual	2.69	0.24	1.20	2.90	41.51

3.3. Weed Similarity Index

Similarity index is the similarity of weed species composition among different Districts. The weed flora similarity index of Adami Tulu JidoKombolcha [ATJK], Dugda, Bora and Negelle Arsi, Districts were above 60% which means 61.76%-63.16% similar weed management methods can be used to control, while species composition was manly dissimilar between ATJK and Shashemanne; ATJK and Lume; ATJK and Kofele Districts with similarity index of 34.88%, 39.58%, and 53.78%, respectively [Table 4]. This might be because of the variation in soil, climatic and management practice of weeds among locations. This might be because of the variation in soil, climatic and human practices among these locations. Similarly, [19-21] reported that weed flora of crop differs from area to area and field to field depending on environmental conditions, irrigation, fertilizer use, soil type, weed control practices and cropping sequences [22].

Table 4. *Characteristic feature of similarity index of weed species compositional in wheat fields.*

District	ATJK	Dugda	Bora	Lume	Negelle A	Shashe	Kofele
ATJK	100.00%	66.93%	61.76%	39.58%	63.16%	34.88%	53.78%
Dugda		100.00%	65.00%	43.40%	48.90%	33.33%	44.20%
Bora			100.00%	46.67%	63.63%	35.72%	100.00%
Lume				100.00%	42.22%	29.10%	38.30%
Negelle A					100.00%	44.74%	100.00%

District	ATJK	Dugda	Bora	Lume	Negelle A	Shashe	Kofele
Shashe						100.00%	48.65%
Kofele							100.00%

4. Conclusion

In the current study, a total of 34 fields were surveyed for weed flora and fauna of Wheat crops, and different weed families and species were identified in the East Shewa and West Arsi zones. The importance of each species was determined by calculating the Frequency, dominant, Density and similarity index values. Generally, annual broad weed leaves dominated over grass and sedge types in the Wheat fields. The most dominant families according to frequency and number of weed species were *Asteraceae, Poaceace, Solanaceae and Amaranthaceae.* The most frequent and dominant weed species consisted of *Galensoga Palviflora, Argemen Mexicana and Nicandra physlodas* for Wheat crops fields.

The current study has documented important weeds of Wheat in representative and potential Agro-ecologies of the respective crops. As the weeds recorded were described in detail - by families, species and frequency, this information can be useful to prioritize weed management research and management strategies to pursue in the future for the various crops and districts.

5. Recommendation

1) *High Similarity (>60%)*: Adami Tulu JidoKombolcha (ATJK) with Dugda, Bora, and Negelle Arsi.
2) *Low Similarity (<60%)*: ATJK with Kofele, ATJK with Shashemanne and Lume.

The differences in similarity indexes are likely due to variations in soil type, climatic conditions, and human practices in these districts.

The information generated through this study is further useful to recommend low-cost, effective and easily available weed management methods for farmers.

Abbreviations

MASL	Meter Above Sea Level
ATJK	Adami Tulu Jido Kombolcha

Author Contributions

Gobena Tesfaye: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Software, Visualization, Writing – original draft, Writing – review & editing

Feyisa Begna: Funding acquisition, Investigation, Project administration, Validation

Adisu Longle: Data curation, Funding acquisition, Validation

Conflicts of Interest

The authors declare no conflicts of interest.

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